Foam problems

Are you still awake?

- Why do we have foam problems?
- What are the most common causes?
- How do we prevent foam-related problems?

My foam-related experience

1. First spray foam project was in 1971
2. Foam SIP manufacturing from 1973 to 1979
3. Foam contracting from 1979 to 2009
   - Developed the method for injecting closed-cell foam on site
   - Installed ~ 3 million pounds of foam
4. Noteworthy foam projects include:
   - Bruce Museum, The Big Dig, 4 American Ski Grande Hotels in the Northeast, Net-zero energy weather station in Antarctica, The Guggenheim Museum
5. Two US patents and two published technical papers related to foam products and quality assurance

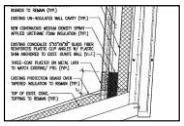
Out of the thousands of projects we completed in the 30 years I was a foam contractor, I can only remember four projects where we had material quality call-backs.

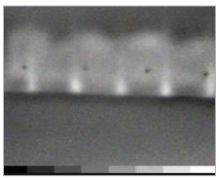
IPF – Bulk foam

Infrared QA of foamed-in-place insulation – effective year-round (240F)

IPF – Bulk foam

Infrared QA of foamed-in-place insulation behind 1" plaster – effective year-round (240F)





My message

- Most foam applications result in very high-performing building enclosures.
- Once in a while, things can go wrong.
- How can we as owners, designers, inspectors, contractors, installers, and administrators be sure that we get the best possible results?
  - Specify or require quality assurance in your projects
  - Perform quality assurance protocols during the work
  - Verify quality assurance after the work

QA = Product Quality and IAQ Safety

Background

Why do I call them foam problems, not foam failures? Not all problems are defects in the foam materials!

1. Perception problems (Owners – bad press)
2. Chemical problems (Manufacturer and/or Installer)
3. Design problems (Design professional, GC if no designer, Owner if neither)
4. Preparation & installation problems (Installer)
5. Inadequate follow-up (any or all of the four)

Comment: In the old days, the contractor was responsible for all of the technical and design issues, plus training and education. Now, it is only #2 and #4.

Not all problems in projects with foam are related to the foam product or the foam installation.
SPF can't seal the wood-to-wood AB connections

Brief outline

- Why are problems occurring on projects that include foam?
- What are the causes of foam problems/ failures? (some are both)
- How can we avoid foam problems?
- And, who am I talking to? Owner/Designer, General Contractor/Foam Installer?

Why are problems occurring on projects that include foam?

Why are problems occurring on projects that include foam?

1. Lack of standards and training
2. There is a lot for a new Foam Installer to learn
3. There are Design issues
4. It's not my problem syndrome
5. I have been doing it that way forever!

Why are problems occurring on projects that include foam?

There are no installation standards and not enough training

- There are no national ANSI standards and certifications
  - Industry guidance documents are "inadequate," but getting better – new 2013 certification program launched
- Inadequate installer training and/or experience
  - Where have all the old sprayers gone…? story
  - The "Cleveland Museum experience" story
  - The "Is Installer A certified to install your product?" story
- Foam problems are not usually advertised by the Installer, manufacturer, or the referral source
  - There are often legal issues associated with settlements
  - It is bad for the industry, so the manufacturers don't…
  - The Katz experience

Why are problems occurring on projects that include foam?

2. There is a lot to learn for a new Foam Installer
   - ASTM, NFPA, State and local zoning and fire regulations
   - OSHA, NIOSH, Industrial Hygiene Assoc., etc.
   - Foam and Chemical trade association guidance documents for "best practice"
   - Building science, materials science, chemistry
   - Codes (International, State, Local, and then there are standards)
   - How to use the equipment properly

Guidance Documents

AY-141 Spray Polyurethane Foam and Cathedral Roofs and Cathedralized Attics

- To vent or not to vent...for typical applications for SPF.

AY-147 Spray Polyurethane Foam for Hybrid Insulation Systems - Part 2: Climate Zones 4-7

- Provides a set of best practices for installing SPF in a hybrid insulation applications. Hybrid insulation systems covered in this document include the use of low-density and medium-density spray foam for insulation and air sealing in combination with air and moisture permeable insulations.

AY-148 SPF Insulation Installation Certificate

- This form must be completed and posted to comply with building code requirements for insulation levels and fire safety. This form is intended to be a guide or template only.

Make sure to follow:

Guidance on Best Practices for the Installation of Spray Polyurethane Foam (ACC Center for the Polyurethanes Industry and the Spray Foam Coalition)

A significant amount about worker safety and…

One sentence – "…spray out a small amount of material to verify the quality of the SPF produced"

2013

Material selection

For the Installer

- Processing data is different for each product – does it work with his equipment?
- Equipment requirements may change from lot to lot – does he have to recirculate the material?
- Installation instruction data – different ambient temperatures, pass thicknesses, approved locations
- Shipping and handling data – temperatures, shelf life, etc.
- Manufacturer technical support capabilities – where and when?

Pop quiz: Can all spray foams be used on walls and roofs?

Product Data Sheet

PROCESSING CHARACTERISTICS AND RECOMMENDATIONS

RECOMMENDED PROCESSING TEMPERATURES	Preheater	Hose
Component A	100-130°F	100-130°F
Component B	110-130°F	100-130°F

These temperatures are typical of those required to produce acceptable product using conventional Gusmer or Grace equipment. Environmental conditions may dictate the use of other temperature ranges. However, under no circumstances should a temperature of 140°F be exceeded. It is the responsibility of the applicator to determine the specific temperature settings to match the environmental conditions and his own equipment.

PROCESSING CHARACTERISTICS

Machine Mix at recommended temperatures*	Winter	Regular
Cream Time	1 second	2 seconds
Tack Free Time	On Rise	On Rise
Cure Time	4 Hours	4 Hours

Building movement

Will the foam crack or delaminate if the building moves?

Does foam crack because a building moves?

How to avoid this potential problem

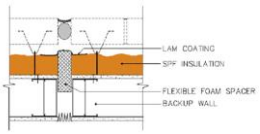
- Anticipate building movement in the design
- Be sure of substrate compatibility
- Prepare substrates properly
- Test the material and the application

Building movement

Anticipate building movement in the design

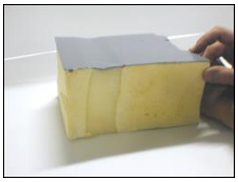
- Provide control joints
- Relieve stresses with surface cuts or bond breakers where necessary – also a QA method
- Use flexible membranes on substrates that move, and at transitions between materials that move at different rates

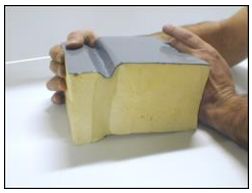
Control Joints



Control Joints

Allow movement to relieve stress, maintain air barrier continuity





Building movement

Will the foam crack or delaminate if the building moves?

Answer: Significant building failure will occur long before the foam will crack or “fall off” if the building is designed properly.

What are the causes of foam material problems?

What are the causes of foam problems?

- Chemical problems
- Site processing problems
- Installation problems
- Post-installation problems

Chemical problems

Before the installation

- QA problems at the factory – record the lot numbers used for each project
- Too hot or too cold during shipping
- Too hot or too cold during storage. Do not store above 86F or below freezing

During the installation

- The rig is too hot or too cold during the installation
- The ambient and/or substrate are too hot or too cold
- Process-equipment heaters are not working properly
- Kit or can materials are too hot or too cold

Delivered too cold

Cold weather issues

A-side: There are only three manufacturers of isocyanate, so temperature requirements should be the same for all foam products. Can cool down to -0F before being damaged

B-side: This brand can go down to -10F before it is damaged. Do not mix when it is warm. 245fa will boil out at 59F, 79F when in solution. So only mix the B-side up to 55F.

Chemical problems

1. The chemicals are prone to stratification when stored (mechanical mixing or recirculation may be required, but this can release the blowing agent)
2. Work-arounds for each
   a. Specify processing to the manufacturer's specs.
   b. Require process monitoring records as a submittal (temperature/ratio monitor output).

Note: Pressure monitoring is not a true indication of ratio – pressure changes with temperature and up and down-stream restrictions, while flow is specific to the ratio of the chemicals to each other.

The top 3 causes

Let's assume that we only buy top-quality chemicals and they are delivered to the foam installer in good shape. So what are the top 3 issues that cause almost all of the foam material problems/failures (my estimates)?

1. Site Processing problems
   - Off-ratio and off-temperature processing (50%)
2. Installation technique
   - Pass thickness (35%)
3. Surface preparation (15%)
   - Wet surface or high moisture content
   - Too hot or cold
   - Release agent on the surface - waxy beams, vent chutes form bond break

Site Processing problems

What are the causes of foam problems?
Field processing problems

1. The pump/proportioner goes off ratio
2. The mix is not adequate
3. The drum pumps, proportioner, and hose heat are not properly set or maintained
4. Inadequate QA control systems in place to avoid problems when changes occur after the initial equipment start-up (Ideally use temperature and ratio monitors with shut-down capability)

Hint: Require processing QA reports in your submittals to assure product quality

Installation problems - processing

1. Off-ratio and off-temperature processing (50%)
   - Poorly processed material, even if it reacts to a large extent will not be:
     - Dimensionally stable (cracking, shrinkage)
     - Well bonded to otherwise compatible substrates (delamination)
     - A reliable air barrier material
   - Poorly processed material, even if it reacts to a large extent may:
     - Release gasses from un-reacted raw material
     - Give off odors
     - Have a lower R-value
     - Have a higher perm rating

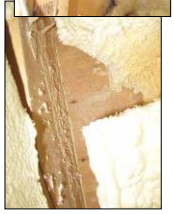
What are the causes of foam problems?
Things change!

Photo DSCN1993.jpeg

Photo DSCN2003.jpeg

Pictures of cracks along rafters in the House attics. The one on the right has been temporarily stuffed with batt insulation until the remediation work begins.

Wet and cold substrates



Note the lack of adhesion at the roof sheathing and rafter

Off ratio – B-rich

Low-tech froth equipment with no monitoring capabilities

Off ratio – B-rich

After replacement

How to stop processing problems

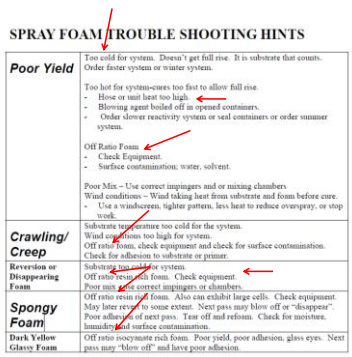
Four types of QA for foam plastic = causes

1. Design
   - Verify that the right type of foam is being used for the application
   - Verify that the design reflects good building science for the specific application
   - Verify the intent (product quality and application performance) of the design
2. Chemicals
3. Installation
   - ***Processing***
   - Technique
4. Installation follow-up
   - Maintain minimum cure requirements

Comment: In the old days, the contractor was responsible for all of these, plus training and education. Now, it is only #2 and #3.

Installation problems - processing

Industry processing & installation troubleshooting guide



SPRAY FOAM TROUBLE SHOOTING HINTS

Poor Yield	Too cold for system. Doesn't get full rise. It is substrate that counts. Order faster system or winter system. Too hot for system-cures too fast to allow full rise. - Hose or unit heat too high. - Blowing agent boiled off in opened containers. - Order slower reactivity system or seal containers or order summer system. Off Ratio Foam - Check Equipment. - Surface contamination; water, solvent. Poor Mix – Use correct impingers and or mixing chambers Wind conditions – Wind taking heat from substrate and foam before cure. - Use a windscreen, tighter pattern, less heat to reduce overspray, or stop work.
Crawling/ Creep	Substrate temperature too cold for the system. Wind conditions too high for system. Off ratio foam, check equipment and check for surface contamination. Check for adhesion to substrate or primer.
Reversion or Disappearing Foam	Substrate too cold for system. Off ratio resin rich foam. Check equipment. Poor mix – use correct impingers or chambers.
Spongy Foam	Off ratio resin rich foam. Also can exhibit large cells. Check equipment. May later revert to some extent. Next pass may blow off or "disappear". Poor adhesion of next pass. Tear off and refoam. Check for moisture, humidity and surface contamination.
Dark Yellow Glassy Foam	Off ratio isocyanate rich foam. Poor yield, poor adhesion, glass eyes. Next pass may "blow off" and have poor adhesion.

Product Data Sheet

RECOMMENDED SUBSTRATE TEMPERATURES

At time of application	RT2045 Winter	RT2045 Regular
Minimum	40°F	60°F
Maximum	80°F	120°F

For applications below 40°F, FOAM-TECH personnel should be consulted. At the lower end of the indicated temperature ranges, flash passes should be avoided.

Extreme pass thickness on a hot roof

Thermal shock plus deep pass thickness

Installation problems - processing

How can we prevent these problems?

"Quality Assurance/control = IAQ Safety"

Off-ratio and off-temperature processing (50%)

- This is the big one, it can be handled with **built-in quality control equipment**
- This equipment is about a $5,000 to $10,000 upgrade
- Avoiding one drum run-out event can save hundreds of dollars, and a typical bulk foam installer uses at least one set of drums per day
- Removal, cleanup, replacement, and disposal for one off-ratio installation can cost tens of thousands or even millions of dollars to remediate.

Installation problems - processing

Can you do it?

Processing Equipment

2:1 transfer pumps are recommended for material transfer from container to the proportioner. The plural component proportioner must be capable of supplying each component within ± 2% of the desired 1:1 mixing ratio by volume. Hose heaters should be set to deliver 120°F to 135°F materials to the spray gun. These settings will ensure thorough mixing in the spray gun mix chamber in typical applications. Optimum hose pressure and temperature will vary with equipment type and condition, ambient and substrate conditions, and the specific application. It is the responsibility of the applicator to properly interpret equipment technical literature, particularly information that relates to the acceptable combinations of gun chamber size, proportioner output, and material pressures. The relationship between proper chamber size and the capacity of the proportioner's pre-heater is critical. Mechanical purge spray guns (specifically

Processing quality control

What QA methods that can meet and verify this tolerance?

- Option 1 – use a ratio and temperature monitor with output to provide documentation of compliance.
- Option 2 – use processing equipment that has automatic shutdown if the processing is off ratio or temperature requirements are not met.
- Option 3 – use scales with real-time weights to monitor material use, A:B. If automatic shut-down at preset weight differential is not part of the system, provide full-time manual oversight of this system.

Processing quality control

What QA methods that can meet and verify this tolerance?

Option 4 – provide the following documentation

- Provide written information from Bayer that stipulates what the installer has to do as an alternative to ratio monitoring to achieve this maximum deviation requirement.
- Provide a written copy of the "Tune-up" report from a qualified equipment service.
- Certify in writing that the equipment met the manufacturer's processing requirements during the entire installation.
- Provide a test report from the manufacturer verifying that physical samples taken at intervals during the installation were processed properly (mix, ratio, physical properties, etc.).

Test sample A-to-B ratio analysis – Lab only

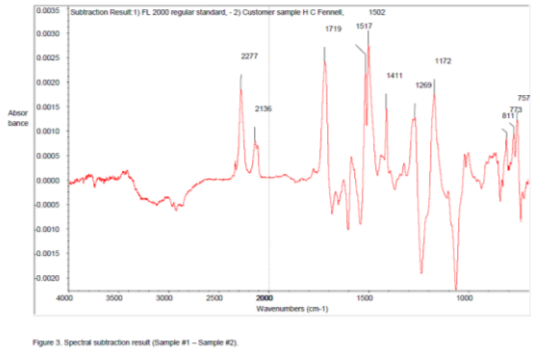


Figure 3. Spectral subtraction result (Sample #1 – Sample #2)

Short-term off-ratio event

Short-term off-ratio event

The following are RATED AC, AL

Remember, these are rare situations, but they demonstrate the implications of inadequate quality control

Infrared locates off-ratio material

Pattern analysis discovers off-ratio material

Foundation walls that required remediation





Full-time off-ratio event






The remediation process - removal

Removal was required as this was a Type II problem





Product Data Sheet

PROCESSING CHARACTERISTICS AND RECOMMENDATIONS

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Product Data Sheet

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Product Data Sheet

FLAMMABILITY CHARACTERISTICS*
SURFACE BURNING CHARACTERISTICS*

ASTM E-84*	3"	4"
Flame Spread*	25	25
Smoke	400	400

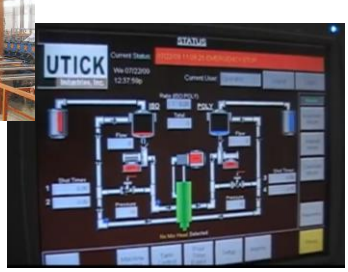
Sample spray applied at 1/4" Cement Asbestos Board.

*Note: This numerical flame spread and all other data presented is not intended to reflect the hazards presented by this or any other material under actual fire conditions.

CAUTION: Polyurethane foam produced from these materials may present a fire hazard if exposed to fire or excessive heat (i.e. cutting torches). The use of polyurethane foam in interior applications on walls and ceilings presents an unreasonable fire risk unless protected by an approved fire resistant barrier with a finish rating of not less that 15 minutes. A code definition of an approved "thermal barrier" is a material equal in fire resistance to ½' gypsum board. Each firm, person, or corporation engaged in the use, manufacture, production or application of polyurethane foams products from these resins should carefully examine his end use to determine potential fire hazard associated with such product in a specific use and to utilize appropriate precautionary and safety measures. Consultation with building code officials and insurance agency personnel before application is recommended.

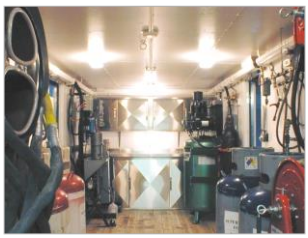
OEM PU Foam processing

QA meters since 1954



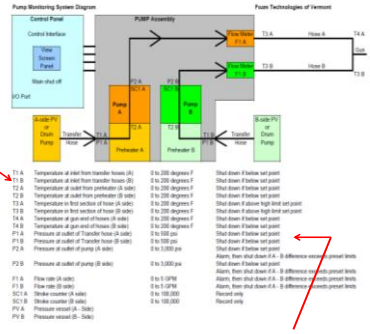
Processing quality control

This is industry-standard off-the-shelf quality control equipment that can eliminate most foam processing failures – specify this type of processing QA for your projects!



Ratio, usage, and temperature monitor with auto shut-off

Note the number of processing parameters that need to be on spec. for good quality control



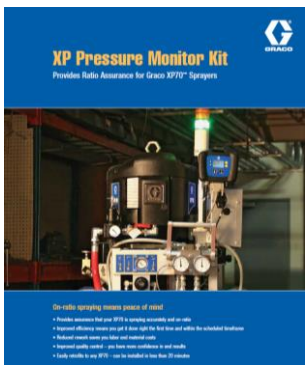
Note that these parameters shut down the pump if the pre-set quality assurance limits are exceeded

These are the two main components of a temperature and ratio monitoring system.

Miscellaneous accessories needed for a complete monitoring system include the following:

1. Thermistors and wire to locate at the gun, in the hoses, and right after the primary heaters.
2. In line air valve to shut off pump if electrical lock-out is not easily available
3. Electrical outlet with surge/overload protector at monitor plug in
4. Remote alarm or warning light if used in addition to built-in alarm

Graco



Graco

Accurate, on-ratio dispense means less waste, more profits

With the Graco HFR Metering System, you accurately measure a specific ratio and volume – first time, every time. As the machine dispenses material, it automatically fine-tunes and adjusts to achieve a consistent material flow or pressure. With a ±1% ratio accuracy, you reduce scrap and rework with accurate, on-ratio dispensing.

Installation problems

Installation problems

Technique

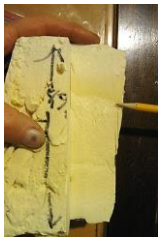
1. Passes/lifts are too thick/high
2. Not enough time between passes
3. Installing SPF when the relative humidity is 80% or above
4. Improper spray pattern sequencing (picture framing, fillet pattern, etc.)
5. Improper response to substrate and environmental conditions
6. Proper work-around protocols not used for extreme environmental conditions when "the work must go on"
7. More about IPF protocols in the applications section
8. Improper product and performance quality assurance protocols

See SPFA: AY-145 Surface Texture of Spray Polyurethane Foam

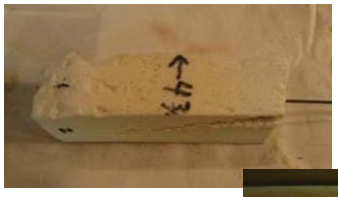
Installation problems – pass thickness

2. Pass thickness above the maximum recommendation (35%)

- Foam installed with too-thick passes will not be:
  - Dimensionally stable (cracking, shrinkage)
  - Well bonded to otherwise compatible substrates (delamination)
  - A reliable air-barrier material
- Foam installed with too-thick passes could:
  - Have a lower R-value
  - Have a higher perm rating
  - Have a lower compressive strength
  - Be prone to scorching and burnout
  - Give off odors
  - Produce voids in the insulation



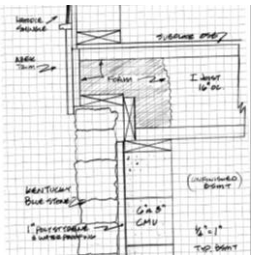
Pass thickness field test



Require Work Report and QA Submittals to assure product quality & encourage patience

Design for a pass thickness failure

Deep rim joist design with a spray foam spec.



Design for a pass thickness failure

One 11" pass with an 1-1/2" lift spray foam product




Removing an SPF sample for density testing

Low-tech Schedule 40 PVC cutter for deep sections


Too hot - burnout

2012 Cape Cod attic fire

Installation problems

Now we have to worry about thickness and how long to wait between passes?

Per Lift Application
Applicators should apply a maximum pass thickness of 2 inches, with a minimum of 30 minutes between passes.

Health and Safety Information
Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when han-

Installation problems – Pass thickness

How can we prevent these problems?

2. Pass thickness above the maximum recommendation or inadequate wait time between passes (35%)

- Unfortunately, this is a behavior issue. Training is important, but when the installer is in an awkward, hard to reach, or confined space, he just wants to get the work done. Quality control, including core and total insulation thickness sampling, by another member of the installation team or a third party, is probably the best way to encourage the type of patience this requires. Good personal protection equipment and safe work cycle limits can also make difficult (hot, etc.) conditions more tolerable.

Installation problems – wait time

How can we prevent these problems?

2. Pass thickness above the maximum recommendation or inadequate wait time between passes (35%)

- The Owner/Designer should specify random core sampling and slit tests to further encourage proper technique in order to protect the Owner from problems. Require sampling reports and certifications in the project submittals.
- Sometimes this occurs when difficult access or enclosed cavities are specified for insulation with a spray foam product rather than cavity-fill slow-rise formulations. Foam installers should use froth or pour formulations for large closed-cavity installations, and use slow-rise kits for incidental accessory work. (stud corners, closed rim joists, boxed headers, etc.)

Diagnosing foam problems

Stress testing - Dimensional stability

Diagnosing foam problems

Slit test that opened up – sounded like a gun shot! Excessive pass thickness was the cause.

Installation problems - preparation

3. Surface preparation/verification (15%)

- Substrate compatibility – foam doesn't adhere to all substrate materials
  - Foam will not adhere to Teflon, water, ice, or snow
  - The substrate isn't fully adhered to the structure, or de-bonds when exposed to exothermic heat
  - Foam does not stick to polyethylene (Ice and Water Shield, some air and vapor barrier materials)

Installation problems - preparation

3. Surface preparation/verification (15%)

- Surface conditions
  - The substrate is wet or has a high moisture content
  - The substrate is too hot or too cold
  - There is a release agent on the surface (waxy LVL beams, oily galvanized steel, oily mill finish aluminum, some transition membranes and roofing fabrics)
  - The substrate is not attached to the structure

Compatibility

Substrate material compatibility for foamed-in-place polyurethanes

Substrate Materials - General Description	Product/Brand name	Adhesion rating	Preparation	Maximum moisture content allowed
Plastics / membranes				
Polyethylene films and membranes		Poor	N/A	N/A
Polytetrafluoroethylene (PTFE) products		Poor	N/A	N/A
Polypropylene products	Tyvek, Typar, etc.	Moderate	N/A	N/A
Glass fiber reinforced products				
Reinforced plastic membranes (Poly, TPO, PVC, etc.)	Reinforced polyethylene (many brands)	Varies with plastics (see this list for the plastic film to assess compatibility)		N/A
Reinforced bituminous membranes	Many	Varies with membrane - note that most bituminous-based product can soften or melt from the heat of reaction - this can temporarily compromise bond strength of the substrate		N/A
Reinforced in paper membranes (Scrim)	Many	Good	Verify paper is not coated with a plastic or wax that may reduce bond strength	Value unknown, but integrity of the paper is important
Polyester resin sheet goods with integral glass fibers (Corvettes, tub-showers units, translucent roofing, etc.)	Fiberglas	Moderate	Clean and dry*	N/A
Peel-and-stick membranes				
Products with polyethylene film finish	Ice and Water Shield	Poor	Torch	N/A
Products modified to accept foam	Bluskin, Perm-A-Barrier	Moderate	Clean and dry*	N/A
Polyurethane and Isocyanurate board stock	Tuff-R, Therman	Good	Clean and dry*	N/A
Polystyrene foam				
Expanded	Styrofoam EPS	Good	Clean and dry*	N/A
Extruded	Styrofoam XPS	Good	Clean and dry*	N/A

Compatibility

Substrate material compatibility for foamed-in-place polyurethanes

Substrate Materials - General Description	Product/Brand name	Adhesion rating	Preparation	Maximum moisture content allowed
Wood products				
Construction grade spruce	Many	Good	Clean and dry*	< 11%
Pressure treated lumber	Many	Varies	Clean and dry*, free of preservative buildup	< 11%
Wood boards	Rough-sawn and planed			
Glue-laminated beams & joints				< 11%
Natural wood face layer	Many	Good	Clean and dry*	< 11%
Waxed finish	Many	Poor	Apply bonding material	< 11%
Plywood				< 11%
Standard wood	Many	Good	Clean and dry*	< 11%
Pressure treated	Many	Varies	Clean and dry*, free of preservative buildup	< 11%
OSB				< 11%
Smooth side	Many	Moderate	Sand and/or prime	< 11%
Rough side	Many	Good	Clean and dry*	< 11%
High and medium-density composite wood panels				< 11%
MDO	Many	Moderate	Sand and/or prime	< 11%
Particle board	Many			< 11%

Compatibility

Substrate material compatibility for foamed-in-place polyurethanes

Substrate Materials - General Description	Product/Brand name	Adhesion rating	Preparation	Maximum moisture content allowed
Metals				
Steel				
Mill-finish cold rolled sections	Many	Moderate	Clean and apply etching agent/primer	
Mill-finish coil stock	Many	Poor	Clean and apply etching agent/primer	
Primed and/or painted	Many	Good	Clean and dry	
Galvanized steel - Spangled	Many	Poor	Apply etching agent	
Galvanized steel - Hot dipped	Many	Moderate	Prime	
Galvanized steel - Cold coated	Many	Moderate	Prime	
Galvanized steel - with paint-prep. galvanization process	Galvalume	Good	Clean, dry, free of oil and grease, or uncured solvent-based materials	
Aluminum				
Mill-finish		Poor	Etching & prime	
Primed and/or painted		Good	Clean and dry*	
Galvanized - Galvalume		Moderate	Clean and dry*	
Aluminum foil facers on RFB		Moderate	Clean and dry*	
Coatings				
Bituminous coatings	Tar, foundation coatings, vapor barrier coatings	Poor	May delaminate from heat of reaction	
Water-based coatings	Foundation coatings, vapor barrier coatings	Varies by product - verify with manufacturer	As directed by manufacturer	
Polyurea	Many	Good	Clean and dry	
Oil and water-based paints	Many	Good	Clean and dry	

Compatibility

Substrate material compatibility for foamed-in-place polyurethanes

Substrate Materials - General Description	Product/Brand name	Adhesion rating	Preparation	Maximum moisture content allowed
Masonry/glass				
Aged poured-in-place or pre-cast concrete	Many	Good	Clean and dry*	
Fresh poured-in-place or pre-cast concrete	Many	Varies	Clean and dry*	
Concrete block	Many	Good	Clean and dry*	
Brick	Many	Good	Clean and dry*	
Stone		Good	Clean and dry*	
Ceramic clay block	Many	Good	Clean and dry*	
Ceramic tile - natural	Many	Good	Clean and dry*	
Ceramic tile - glazed	Many	Moderate	Clean and dry*	
Glass fiber products	Open mesh	Good	Clean and dry*	N/A
	Woven roving	Good	Clean and dry*	N/A
Paper faced gypsum board	Standard gypsum wall board	Good		
	Exterior gypsum board (Densglas)	Moderate		
Plaster		Good		
Window glass	Many	Moderate	Clean and dry*	
Foam glass board stock	Many	Moderate	Clean and dry*	

Installation problems - preparation

How can we prevent these problems?

3. Surface preparation/verification (15%)
   - The Owner/Designer should specify compatible substrates where foam is to be applied, or specify pull-testing prior to the installation when substrate compatibility is unknown (mockups, etc.).
   - The Installer should verify that his products will adhere adequately to any material that is not a standard substrate by doing pull testing and that the substrate itself is fully adhered or mechanically fastened.

Material compatibility

You can test materials at home instead of in the field – before you have a problem on a building

1. Natural cure shrinkage – as the gas in closed-cell foam cools, it contracts
2. Heat of reaction reduces substrate bond strength

Material compatibility

Field adhesion/pull test

CMU with VB coating

Field adhesion/pull test

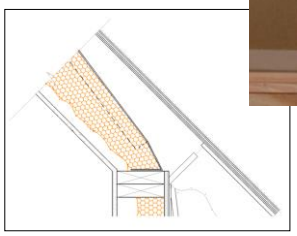
Glazed terra-cotta tile

Heat-of-reaction

Bituminous VB coating loses bond due to heat-of-reaction

Preparation problem

No bonding surface due to incorrect location of the cardboard vent chute

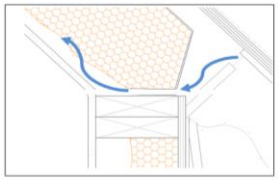


Not enough room for specified R-value ~3" for R-38 min.

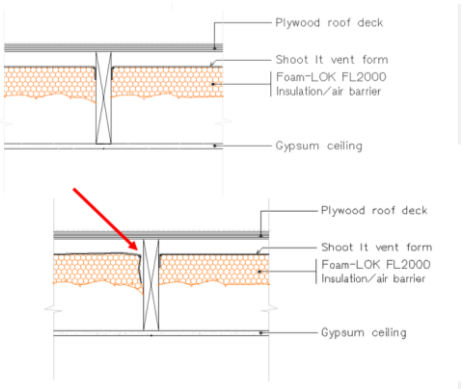
Preparation problem

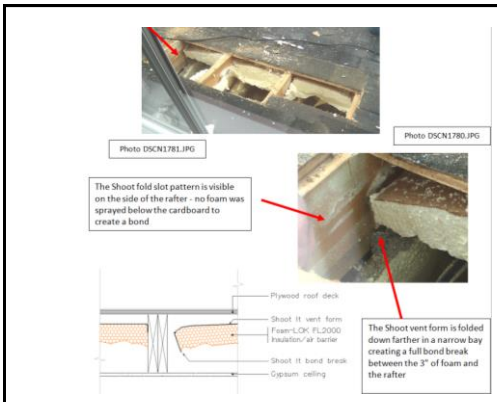
Daylight is visible under the cardboard vent chute form

Photo DSC_4966.JPG

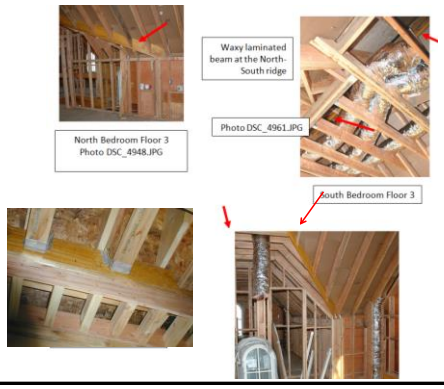


Air bypass under the cardboard vent form





Installation problems - preparation



Installation problems - preparation

How can we prevent these problems?

Substrate compatibility

- Eliminate or plan for known material incompatibilities
- Verify unknown material bond strength with a pull test
- Verify unknown material bond strength with heat stress tests
- Consider heat of reaction bond release
- Consider cure pull of adhered substrate layers

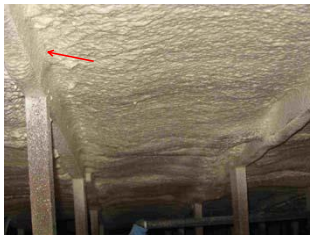
Installation problems

Technique

1. Passes/lifts are too thick/high
2. Not enough time between passes
3. Installing SPF when the relative humidity is 80% or above
4. Improper spray pattern sequencing (picture framing, fillet pattern, etc.)
5. Improper response to substrate and environmental conditions
6. Proper work-around protocols not used for extreme environmental conditions when "the work must go on"
7. More about IPF protocols in the applications section
8. Improper product and performance quality assurance protocols

See SPFA: AY-145 Surface Texture of Spray Polyurethane Foam

Good technique



Good technique also saves material ($)

Good technique

Better depth control

Self-supporting

Good technique

Below-grade application

Good technique

Note the "fillet edges" detail along the rafters

Unvented roof application

Good technique

Food processing facility

Poor technique

Lack of over-spray protection, multiple foam products, uneven texture, voids

Poor technique

Uneven texture, voids

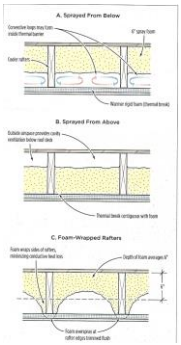
Poor technique

Technique – Specialty Approved Foam

Good technique

The picture framing technique will ensure that insulation seals cracks and crevices without resulting in fold-over along the stud face or air-pockets or voids which will affect the insulation's performance.

Good technique



Good technique also saves material ($)

Average foam thickness with fillet edges is more effective per unit of foam

JLC article, 2005

Poor technique

Photos # DSCN1996.jpeg, IMG_2160.jpg, and DSCN2004.jpg

Post-installation problems

Typical post-installation problems

1. Inadequate quality assurance protocols
2. Failure to maintain minimum cure requirements – thermal shock
3. Lack of protection against damage by related trades (open flames, air-barrier penetrations for mechanical systems, etc.)

Product Data sheets and ESRs report cure requirements – specify and verify compliance with the manufacturer's requirements.
Temporary insulation can extend the installation window.

Quiz questions:

- Foam products can be damaged prior to the installation?
- Problems in field-applied polyurethane foam plastic installations are always the fault of the foam installer?
- All foam products are generally equal in terms of their physical properties and performance?
- All foam installations need the same quality assurance tests?
- All foam products meet the code requirements without additional accessory materials?
- The most common cause of foam problems is bad spray technique by the installer?
- The ICC codes require all foam installers to have to have the same minimum qualifications?